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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/804,810	03/19/2004	Jonathan J. Wierer JR.	LUM-03-05-01	8900

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EXAMINER	
HO, TU TU V	

ART UNIT	PAPER NUMBER
2818	

DATE MAILED: 04/05/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/804,810	WIERER ET AL.	
	Examiner	Art Unit	
	Tu-Tu Ho	2818	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 March 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-28,32 and 33* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-28,32 and 33* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *19 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. Applicant's Amendment filed 03/22/2006 has been reviewed and placed of record in the file.

2. Applicant's arguments with respect to amended claims 1-28 and 32-33, filed 05 August 2002, have been considered but they are moot in view of new ground(s) of rejection. Applicant's intention of submitting an appropriate declaration to establish priority over Erchak et al. U.S. Patent 6,831,302 (the '302 reference) is acknowledged.

Claim Rejections - 35 USC § 102

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

3. **Claims 1-2, 4, 8, 13-14, 17-21, and 26-27** are rejected under 35 U.S.C. 102(e) as being anticipated by Erchak et al. U.S. Patent 6,831,302 (the '302 reference, cited in a previous office action).

The '302 reference discloses in Fig. 1 and respective portions of the specification a light emitting device as claimed.

Referring to **claim 1**, the '302 reference discloses a light emitting device comprising:

a (group-) III-nitride semiconductor structure including an active region ("light generation region" 130, column 9, line 10-25) disposed between an n-type and a p-type region (134 and 128); and

a photonic crystal structure (generally indicated at holes 150) formed in at least a portion of the n-type region (134); and

a metal reflector (126, column 9, lines 53-62) disposed on at least a portion of a surface of the p-type region (128) opposite the active region (130).

Referring to **claim 2**, the reference further discloses that the photonic crystal structure comprises a periodic variation (column 10, lines 10-15) in a thickness of the n-type region (134).

Referring to **claim 4**, the reference further discloses that the photonic crystal structure (generally indicated at holes 150) comprises a planar lattice of holes (150).

Referring to **claim 8**, the reference further discloses that the planar lattice is triangular (column 10, lines 10-15), satisfying the claimed Markush group of a triangular lattice, a square lattice, a hexagonal lattice, and a honeycomb lattice.

Referring to **claims 13 and 14**, since the reference does not teach intentionally filling the holes (150) with a material or removing air from the holes, the holes (150) are filled with air, a natural dielectric material, which has a dielectric constant of 1, which meets the claimed limitation of a dielectric constant of about 1 and about 16.

Referring to **claims 17-20**, the reference teaches that the total thickness of the group-III nitride semiconductor layers including the n-type region (134, having a thickness of 320 nm, column 9, lines 10-20), the active region (130, having a thickness of 120 nm, column 9, lines 10-20), and the p-type region (128, having a thickness of 40 nm, column 9, lines 10-20) is about 480 nm, which is about the thickness as claimed of less than 0.5 μm (500 nm) or of less than 1 μm (1000 nm).

Referring to **claim 21**, the reference further discloses that a portion of the reflector underlies the photonic crystal structure.

Referring to **claim 26**, the reference further discloses that the reflector (126) comprises silver (column 9, lines 14-17).

Referring to **claim 27**, the reference further discloses that the photonic crystal structure is formed in a first portion of the n-type region (134), the device further comprising a contact (136) formed on a second portion of the n-type region, the second portion being substantially free of the photonic crystal structure.

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

4. **Claims 3, 5-7, 9-12, and 15-16** are rejected under 35 U.S.C. §103(a) as being unpatentable over Erchak et al. U.S. Patent 6,831,302 (the '302 reference, cited in a previous office action).

Referring to **claims 3, 6, and 10-12**, although the reference does not teach a range of ratios of the period of the periodic structure and the wavelength of light emitted by the active region as claimed, the reference discloses that the period and the diameter of the holes 150 and the periodic structure of the photonic crystal structure comprising holes 150 can change (column 10, lines 14-16), and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

Referring to **claims 5 and 6**, although the reference does not teach a range of the depths for the holes as claimed, as detailed above, the reference disclose that the depth of the holes can be changed (column 10, lines 10-16), and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

Referring to **claim 7**, although the reference does not disclose a range of greater than a value of the radiation (light) emitting or exiting the device as claimed, the reference teaches improving light extraction efficiency and increasing light output (column 10, lines 25-30), and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

Referring to **claim 9**, as detailed above for claim 8, the reference discloses that the planar lattice is triangular, satisfying the claimed Markush group of a triangular lattice, a square lattice, a hexagonal lattice, and a honeycomb lattice; however, the reference fails to teach that the planar lattice includes more than one lattice type as recited in claim 9. Nevertheless, as the reference does not teach that the planar lattice must be a single planar lattice type, such a change to include more than one lattice type would have been obvious to one of ordinary skill in the art at the time the invention was made.

Referring to **claim 15**, although the reference does not disclose a range of a distance between the reflector and the photonic structure as claimed, the reference teaches that the depth of the holes can be changed (column 10, lines 14-16), and because the holes, which define the photonic structure, do not reach the reflector layer 126, the reference in effect teaches that a

distance between the reflector and the photonic structure can be changed, and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

Referring to **claim 16**, although the reference does not teach a distance between a center of the active region (130) and the photonic crystal region is less than a distance as claimed, the reference teaches that the depth of the holes can be changed (column 10, lines 14-16), and because the holes, which define the photonic structure, do not reach the active region 130, the reference in effect teaches that a distance between the active region and the photonic structure can be changed, and because it has been accepted that manipulation of sizes, shapes, and efficiency is routine skill inherently possessed by a person or ordinary skill in the art, therefore such manipulation would have been obvious.

5. **Claims 1-2, 4, 13-14, 21, and 26** are rejected under 35 U.S.C. §103(a) as being unpatentable over Lester U.S. Patent 6,091,085 (the '085 reference) in view of Scherer et al. U.S. Patent 6,534,798.

The '085 reference discloses in Fig. 7 and respective portions of the specification a light emitting device substantially as claimed.

In particular, the reference discloses a light emitting device as claimed but does not teach a metal reflector and consequently does not teach that the metal reflector is disposed on at least a portion of a surface of the p-type region opposite the active region.

Specifically, the reference discloses a light emitting device comprising:

a (group-) III-nitride semiconductor structure including an active region (18, Fig. 1, col. 2, last paragraph; no number in Fig. 7) disposed between an n-type and a p-type region (col. 2, last paragraph, and col. 5, lines 30-35, which n-type region and p-type region are generally indicated at p-n-junction layer 32 of Fig. 7 and p-type region 14 and n-type region 13 in Fig. 1); and

a photonic crystal structure (generally indicated at hole pattern 35, Fig. 7, col. 5, lines 30-45) formed in at least a portion of the p-type region.

More specifically, the upper doped region of the region 32 of Fig. 7, if formed similarly to Fig. 1, of the reference is a p-type as compared to the n-type as claimed. However, one of ordinary skill in the art recognizes that polarity of the upper doped region can be changed so long as to form two complementary doped regions sandwiching the active region, therefore such changing of the polarity of the doped regions would have been obvious to one of ordinary skill in the art.

As for the limitation "a metal reflector disposed on at least a portion of a surface of the p-type region opposite the active region", Scherer, in also disclosing a light emitting device, teaches that a light emitting device having a metal reflector (such as metal reflector 18, Fig. 1H, col. 5, lines 10-20) disposed on at least a portion of a surface of the p-type region or the n-type region, which he terms collectively as "semiconductor core" (Figs. 1 and 3) opposite the active region (not shown) helps with light output ("quantum efficiencies") of the light emitting device (column 1, lines 20-30). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the '085 reference's light emitting device such that it includes a metal reflector such as the silver reflector 18, taught by Scherer, disposed on at least a

portion of a surface of the p-type region opposite the active region. One would have been motivated to make such a change in view of the teachings in Scherer that such a change results in higher light output for the light emitting device.

Referring to **claim 2**, the reference further discloses that the photonic crystal structure comprises a periodic variation in a thickness of the n-type region (as seen in Fig. 7).

Referring to **claim 4**, the reference further discloses that the photonic crystal structure (generally indicated at holes 35) comprises a planar lattice of holes (35).

Referring to **claims 13 and 14**, the reference further teaches filling the holes (35) with air or a material other than air (col. 5, lines 50-55), which has a dielectric constant of 1, which meets the claimed limitation of a dielectric constant of about 1 and about 16.

Referring to **claim 21**, the reference in view of Scherer further discloses that a portion of the reflector underlies the photonic crystal structure.

Referring to **claim 26**, the reference in view of Scherer further discloses that the metal reflector comprises silver, as noted above.

6. **Claims 1-28 and 32-33** are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Scherer et al. U.S. Patent 6,534,798 (the '798 reference) in view of Lester U.S. Patent 6,091,085 (the '085 reference).

The '798 reference appears to disclose in the Background Art Section and respective portions of the specification a light emitting device as claimed. Specifically, the '798 reference disclose in the Background Art Section that "to build an ideal, highly efficient light-emitting diode (LED), it is desirable to improve the extraction efficiency and simultaneously enhance the

spontaneous emission rate. A 15-fold emission intensity enhancement, with Purcell factor Fp=2 was observed in two dimensional periodic thin film photonic crystals" (col. 1, lines 40-50, emphasis added). The '798 reference then proposes an improvement over the prior art by forming a periodic pattern in a top metal layer overlying a III-nitride light emitting layer (Abstract, columns 1-5, particularly Abstract and col. 1, lines 45-50).

In other words, it appears that the prior art's light emitting device as disclosed by the '798 reference already comprises photonic crystals in one or more of the doped III-nitride semiconductor layers that form the basic of a light emitting device, because the '798 reference proposes forming a periodic pattern in the top metal layer only; and as such the prior art's light emitting device as disclosed by the '798 reference meets the requirement of at least independent claim 1.

In the alternative, the '798 reference proposes forming a photonic crystal structure ("periodic pattern") in the top metal layer overlying a III-nitride light emitting layer (which is termed a "semiconductor core", Figs. 1 and 3), as detailed above. The reference further teaches various sizes and shapes as recited in **claims 3-6, 8-12, and 15-16** (cols. 3-5), teaches that air could fill the photonic crystal structure (Fig. 7), which air has a dielectric constant of 1 as required in **claims 13-14**, further teaches a thickness for the III-nitride layer (Abstract and cols. 3-4) meeting the various thickness of the III-nitride layer as recited in **claims 17-20**, specifically teaches a metal silver layer (18) as required in **claims 1, 21, and 26** (Figs. 1-3, and as detailed above), discloses a host substrate (20, Figs. 1, col. 5, lines 1-50) similar in scope as recited in **claims 22-25**, and although not disclosed, contacts for the light emitting device to function in

similar scope as recited in **claims 27-28** and intended use of the output light as recited in **claim 7**.

However, as noted above, the reference does not disclose forming the photonic crystal structure in a portion of the doped III-nitride light emitting layer.

Lester in the '085 reference, in also disclosing a light emitting device including a III-nitride layer and a photonic structure as detailed above in paragraph numbered 5, teaches that the photonic structure, which is a hole pattern, should extend down into a portion of the doped III-nitride light emitting layer so as to increase light intensity (col.5, lines 20-50).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the '798 reference's device such that its photonic structure extend down into a portion of the doped III-nitride light emitting layer, rather than just the metallic layer. One would have been motivated to make such a change in view of the teachings in Lester that such a modification leads to increased light intensity.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office Action. See MPEP § 706.07(a).

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after

the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tu-Tu Ho whose telephone number is (571) 272-1778. The examiner can normally be reached on 7:30 am - 6:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DAVID NELMS can be reached on (571) 272-1787. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Tu-Tu Ho
March 30, 2006